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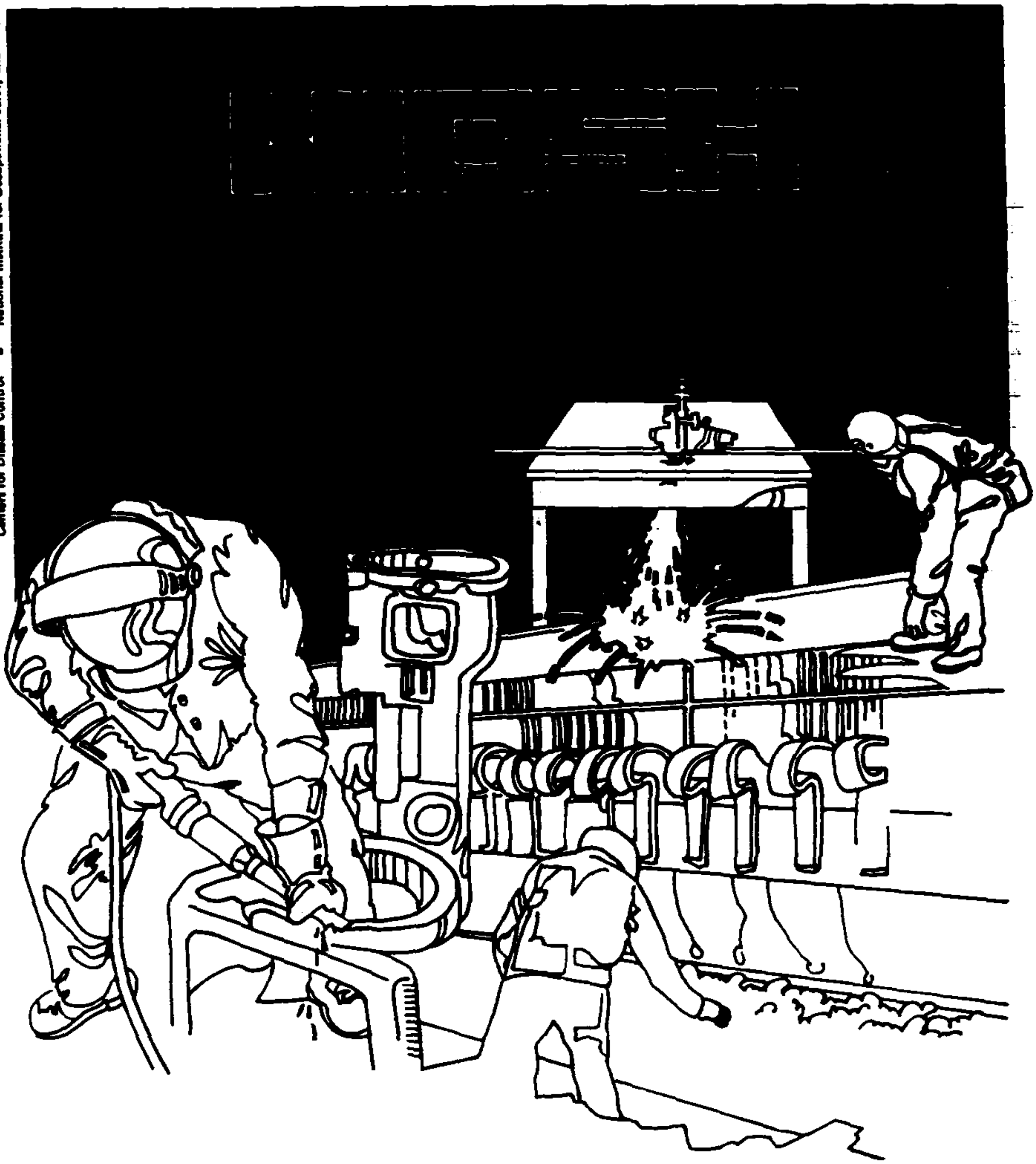

Health Hazard Evaluation Report

HETA 88-229-1985
ORMET CORPORATION
HANNIBAL, OHIO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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I. SUMMARY

On January 17-18, 1989, the National Institute for Occupational Safety and Health (NIOSH) conducted an investigation at the Ormet Aluminum Reduction Plant in Hannibal, Ohio. This investigation was performed in response to a request, which NIOSH received on April 7, 1988, to evaluate exposure to magnetic fields and optical radiation among potroom workers.

Optical radiation and static magnetic field measurements were made in the potroom under normal work conditions over two shifts on January 17-18, 1989 on four of the six pot lines. The maximum levels of far ultraviolet, near ultraviolet, visible, and infrared radiation were found to be non-detectable, 120 uW/cm^2, 0.3 cd/cm^2, and 190 mW/cm^2, respectively. Static magnetic field levels were as high as 1600 gauss at worker's locations.

The infrared radiation and static magnetic field levels exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) guideline values of 10 mW/cm^2 and 600 gauss, respectively. In addition to the radiation levels that could be incident upon the unprotected worker, discussion is also presented on certain work practices involving ergonomic activities that may require changes.

These results suggest that under certain conditions workers can be exposed to excessive levels of infrared radiation and static magnetic fields. Recommendations are made in Section VIII for reducing these exposures.

KEYWORDS: SIC 3334 (Primary Production of Aluminum). Aluminum, Magnetic Fields, Ultraviolet Radiation, Infrared Radiation, Pot Room.

II. INTRODUCTION

On April 7, 1988, NIOSH received a request for a health hazard evaluation to evaluate the potential exposure to magnetic fields and optical radiation among potroom workers at the Ormet Corporation located in Hannibal, Ohio. At the time of the initial request another NIOSH evaluation on respiratory and skin irritation complaints was in progress at the facility (HETA 84-426), therefore HETA 88-229 was not conducted until the first one was completed. On January 17-18, 1989 two NIOSH investigators visited the facility and made magnetic field and optical radiation measurements.

III. BACKGROUND

Ormet Corporation is the third largest aluminum reduction plant in the United States. The Hannibal facility can process a billion pounds of alumina each year in 1032 electrolytic reduction cells (pots). The Hannibal plant is over thirty years old but has undergone modernization efforts. There were approximately 1400 production and salary workers at the facility during the time of this evaluation.

The facility has six potrooms, with each potroom consisting of two buildings each. These buildings are 1000 feet long, housing 86 pots, for a total of 1032 pots (see Figure 1). Each pot contains 20 anodes, with 10 on each side of a pot. There are five shields covering each pair of anodes. There are two electrodes on each rod assembly. Each of the electrodes measure 18" high, 21" wide, and 15" long. Potroom 6 is a computer operated and controlled system.

The aluminum ore at Hannibal is made in rectangularly shaped steel pots lined with anthracite coal containing cryolite, a molten chemical that is the electrolyte. In the pots, aluminum oxide (alumina) is reduced to nearly pure metallic aluminum in a bath of molten fluorides, at a temperature of approximately 1800^{o}F. Due to the high melting point of aluminum oxide, the alumina cannot be smelted by thermal reduction with coke; rather, reduction energy must be supplied electrolytically. Carbon electrodes are used as the anode, and the aluminum metal in the pot acts as the cathode. The electrolytic cells in this facility employ approximately 100,000 amperes D. C. This current is capable of dissolving the alumina in the cell to form aluminum. However, the production of this current also forms high levels of static magnetic fields. In addition, when the aluminum is withdrawn from the cells it is gathered into large metal vats. The aluminum is very hot and concern was voiced about the production of optical radiation in both the pots and vats. A more detailed description of the aluminum production process has been provided in a previous NIOSH report [1].

IV. EVALUATION DESIGN AND METHODS

The following equipment was used to document levels of radiant energy produced by the various processes:

Luminance or brightness levels were measured with a Spectra Mini-Spot photometer having a one degree field of view. The values were obtained in terms of footlamberts (fL) which are converted to candela per square centimeter (cd/cm^2). The luminance of a source is a measure of its brightness when observed by an individual without eye protection, regardless of the distance from source.

A International Light model 730A radiometer, with specially calibrated detectors, was used to evaluate the ultraviolet radiation levels. One detector was designed to read the actinic UV radiation (200 to 315 nm) in biologically effective (eff) units of microwatt per square centimeter (uW/cm^2), while the other detector measured near UV (320-400 nm) in units of milliwatt per square centimeter (mW/cm^2) with no biologic weighting factor.

A Solar Light Sunburn meter was used to document the presence of any erythermal producing radiation in the 290 to 320 nm wavelength region. This meter reads in sunburn units per hour.

A Eppley model 901 calibrated thermopile with a quartz window was used to measure irradiance in units of milliwatts per square centimeters over the wavelength range from 200 to 4500 nm.

A Walker Scientific model MG-50P gaussmeter with a axial probe was used to measure the magnetic fields. All readings were recorded in the root mean squared (RMS) mode. The gaussmeter works on the Hall Effect principal and is designed to measure both DC and AC (RMS) magnetic fields over the range from 0.1 to 20 kilogauss. Background levels of zero were obtained outside of the facility at distances greatly removed from the potrooms before and after recording cell room levels.

All equipment used to document exposure to optical and magnetic fields had been calibrated within six months use either by NIOSH or their respective manufacturer. Measurements were made in and around 4 of the 6 potrooms at locations where workers had been seen working. Most measurements were taken at positions considered to be typical of occupational exposure (3 feet away and 3 feet from the floor).

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed without experiencing adverse health effects. It is, however, important to note that not all exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a preexisting medical condition, and/or a hypersensitivity situation.

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects, even if the occupational exposures are controlled at the level set by the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus, potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information about chemical and physical agents become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH criteria documents and recommendations, 2) the ACGIH's Threshold Limit Values (TLV), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational diseases. In evaluating the exposure levels and the recommendations for reducing these levels found in these reports, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

At present there is limited information from OSHA on exposure criteria for workers exposed to physical agents. Criteria for physical agents not covered by OSHA come from either ACGIH, NIOSH, or in some cases from consensus standards promulgated by the American National Standards Institute (ANSI).

A. OPTICAL RADIATION

1. Infrared Radiation [2-5]

All objects having temperatures above absolute zero emit infrared radiation (IR) as a function of temperature. In biological systems, the major insult of IR appears to occur as a result of a rise in temperature of the absorbing tissue.

The physical factors associated with temperature rise are the wavelength, heat conduction parameters, exposure time, and total amount of energy delivered to the exposed tissue. Since IR photons are low in energy, they would not be expected to enter into photochemical reactions with biological systems. Molecular interactions with radiation in the IR regions are characterized by various vibrational-rotational transitions resulting in an increase in thermal energy of the molecule.

Since the primary effect of IR on biological tissues is thermal, the skin provides its own warning mechanism by having a pain threshold below that of the burn threshold. However, there is no such adequate warning mechanism in the eye and hence additional protective equipment is often necessary. Traditionally, safety personnel consider IR to be a cataractogenic agent but recent literature (see References) has cast serious questions about the etiology of IR cataracts that could occur in the workplace from non-coherent optical sources.

Wavelengths of IR beyond 1400 nm can produce corneal and eyelid burns leading to the conditions of dry eye and skin. The primary biological effect of IR on the retina and choroid is thermal in nature, with the amount of damage being proportional to the length of exposure. If the radiation intensity is low enough, however, the normal retina blood may be sufficient to dissipate any heat generated. Nevertheless, due to the focusing effect of the anterior ocular components, small amounts of IR can produce a relatively intense point energy distribution on the retina resulting in a lesion.

2. <u>Visible Radiation</u> [4,6,8-9]

Visible radiation from either the sun or artificial sources is probably one of the more important occupational health considerations because of its major role in our daily life. When light levels are high at certain wavelength regions certain obvious retinal issues arise that require protective eye wear devices. These types of direct effect have been well known for many years and documentation exists within the scientific literature, i.e., staring at welding arcs or the sun.

Indirect effects of light, however, can occur not from absorption of light energy in tissues but from the action of chemical signals liberated by cells in the body. In many cases such indirect effects occur at much lower intensities than the direct effect. As a result, such effects often are not considered a major occupational health hazard. Examples of this relationship of light to biological rhythms include physical activity, sleep, food consumption, etc. Another well-known indirect effect is the inhibition of melatonin synthesis by the pineal gland which in turn affects maturation and activity of the sex gland. Only within the last few years have investigators begun to discover the various subtle physiological and biochemical responses to light.

Another issue which often arises is that associated with poor room or task lighting conditions. Such conditions lead to or cause asthenopia (eye strain). Although the etiology of eye strain is debatable, it appears that repeated occurrences probably do not lead to any permanent eye damage. Workers over 40 years of age will probably encounter more symptoms of eye strain (headache, tired eyes, irritation) since they require more light to perform a similar job than younger workers.

The ACGIH TLVs for visible radiation exist to offer protection from retinal thermal injury and for photochemical injury that can occur from exposure to wavelengths in the region from 400-500 nanometers.

3. Ultraviolet Radiation [6-7,9]

Ultraviolet (UV) Radiation is an invisible radiant energy produced naturally by the sun and artificially by arcs operating at high temperatures. Some of these sources are germicidal and blacklight lamps, carbon arcs, welding and cutting torches, electric arc furnaces, and various laboratory equipment.

Since the eyes and skin readily absorb UV radiation, they are particularly vulnerable to injury. The severity of radiation injury depends on factors which include exposure time, intensity of the radiation source, distance from the source, wavelength, sensitivity of the individual, and presence of sensitizing agents.

Sunburn is a common example of the effect of UV radiation on the skin. Repeated UV exposure of lightly pigmented individuals may result in actinic skin (dry, brown, inelastic, wrinkled skin). Actinic skin is not harmful in itself, but is a warning that conditions such as senile keratosis, squamous cell epithelioma, and basal cell epithelioma may develop.

Since UV is not visible, the worker may not be aware of the danger at the time of exposure. Absorption of the radiation by the mucous membranes of the eye and eyelids can cause conjunctivitis (commonly known as "welder's flash"). Lesions may also be formed on the cornea at high exposure levels (photokeratitis). Such injuries usually manifest themselves 6 to 12 hours after exposure. The injuries may be very painful and incapacitating, but impairment is usually temporary. Workers need to be aware that there can exist within their workplace photosensitizing agents that, upon contact with the skin, produce exaggerated sunburn when exposed to UV at certain wavelengths.

B. Static Magnetic Fields [4, 10-12]

In general there are two conditions for magnetic field exposures which need to be understood. Exposures can occur either from a steady or time-varying field exposure. In a steady magnetic field the flux does not change with time and will not cause current to flow in a fixed object. In a time-varying field the magnetic flux passing through a surface changes with time and can induce an electrical current flow in conductive objects. Both types of fields create different biological effects.

Exposure to static magnetic fields has been linked to slight increases in blood pressures, alteration in operation of artificial cardiac pacemakers, movement of implanted metal objects, rotation of sickle cells, changes in the circadian cycle, and attractiveness of metal objects. Many scientists believe that the effect of static magnetic fields are very subtle and may not represent a particularly hazardous exposure. There have been no official occupational health limits set for static magnetic fields. The Stanford Linear Accelerator Center proposed, in 1971, values of 2000 to 20,000 gauss, depending on time and exposure area of body, for an upper limit based on lack of complaints. The term gauss refers to the measurement of the magnetic flux density. In 1979 the Department of Energy, based on known biological effects that had been reported, established a level of 20,000 gauss. The only other limit for this type of exposure has been proposed by ACGIH in 1987. Their draft standard recommends that "Routine occupational exposures should not exceed 600 Gauss whole body or 6000 Gauss to the extremities on a daily, time-weighted average basis. A flux density of 20,000 Gauss is recommended as a ceiling value.

Table 1 shows the optical radiation and static magnetic field exposure limits that are used by investigators to determine occupational insult. The levels shown are based on a 8-hour exposure level.

VI. RESULTS AND DISCUSSION

Based on results obtained from preliminary plant-wide measurements made during the visit, it was concluded that occupational exposure levels were not exceeded for visible (luminance) and UV radiation. However, levels of magnetic fields and infrared radiation were measured that could represent occupational concern. Therefore, more measurement emphasis was placed on these latter exposure types.

A. Luminance levels

Measurements of luminance levels were performed at several sites in two potrooms. The highest luminance value recorded (0.03 cd/cm^2) occurred when the hot aluminum was poured into the vat(s). This low luminance level would be expected due to the temperature of the metal flux assuming a black-body thermal distribution. In comparison, measurements made of the mercury vapor lamps in potroom 5, positioned in the ceiling approximately 30 feet off the ground, gave 0.27 cd/cm^2. Visual observations made by the investigators in other potrooms did not suggest luminance levels would be any different from those made in measured potrooms.

B. Ultraviolet Radiation

Levels of UVR, both near and far, as well as solar levels were documented during the evaluation. The actinic levels (200 to 315 nm) were non detectable in two potrooms while the levels of near UV averaged about 135 uW/cm^2 in two potrooms. Some of this contribution of near UV was due to radiation from outside as well as light sources within the facility. The sunburn meter indicated non-detectable everywhere in the facility, except outside. The maximum reading obtained outside (overcast day) was 0.3 SBU.

C. Infrared Radiation

As a result of the magnitude of preliminary measurements made on IR at the facility, an attempt was made to document the IR contribution under several occupational exposure conditions. During observation of job tasks, it had been observed that workers would be exposed to IR from several sources. The three work conditions that appeared to be the most dominant in terms of the IR exposure were (1) locations near a open pot door, (2) locations close to the vat used to hold the molten aluminum as it is withdrawn from the pot, and (3) when a anode replacement event occurred. Using these observations, measurements were then made to account for potential IR occupational exposures.

In the first IR measurement series, irradiance levels were documented with a thermopile held at different distances from a randomly selected pot (pot 5A-20). Holding the meter at eye heights and facing the end of the pot (door closed) gave a value of 7.5 mW/cm^2. Measurements made in the direction away from the pot gave values of 10 uW/cm^2 which conclusively indicates the IR is coming from the pots. The doors were then opened and measurements were made at several distance from the pot. Figure 2 shows the results for these measurements. The highest level is about 20 times the ACGIH TLV and is found where a worker might be positioned while breaking up the slag in the pot. During slag breaking the worker is required to insert a 4 to 5 foot metal bar into the pot and break the slag formed on top of the molten metal. This process is repeated several times a day and takes a few minutes to perform. These measurement were made on the assumption that there was no worker protection other than gloves. If a worker wore eye/face protection the potential exposure would be greatly reduced. While breaking up the slag in a given pot is performed only a few times on a given day, it is possible for the same worker to repeat this action on several pots in a work day, thereby increasing his overall exposure. It should be noted that IR radiation at a level of 10 mW/cm^2, incident upon the whole body, for some period of time might constitute heat stress to some individuals. However, the NIOSH investigators do not believe these slag breaking processes involve whole body irradiation and that sufficient cooling normally does occur to prevent heat stress. The only exception to this statement might be during periods of prolonged hot summer weather.

It should be noted that when the molten aluminum is removed from the pot, a process called extraction, the worker is required to stand in front of the open pot door and insert a metal extraction nozzle into the slag. IR exposure levels can be as high during this time as during slag breaking.

The second measurement series evaluated the contribution of IR radiation to worker's exposure produced by the crucible containing molten material. These measurements were documented at several sites throughout the facility and were found to be quite similar. The highest level measured was on pot line 5A, pot 20, where values ranging as high as 105 mW/cm^2, were documented when the thermopile was pointed at the filled crucible. While it is obvious that some cooling of the molten material in the crucible occurs with time, these results indicate that uncovered crucibles may represent an ocular exposure. The level measured on pot 20 was made within a few minutes after the crucible was filled. It was interesting to note that some workers wore tinted eye protectors when they were working close to the vats, but did not wear them during slag breaking.

Another measurement series was made to estimate worker exposure to the IR emitted by the anode during an air burn-off procedure. In this operation an anode is pulled out of a pot line using a chain suspended from an overhead crane. Normally two to three workers are potentially exposed to IR during this procedure. Exposure from the process occurs in three ways: exposure before the extraction, exposure from the suspended anode, and exposure related to installation of the new anode.

In the first situation measurements made on pot line 5A/Pot#6 indicated that, when the metal shields were removed, the IR levels were about 120 mW/cm^2 three feet from the anodes. This greatly exceeds the ACGIH TLV for infrared radiation of 10 mW/cm^2. Once the old anode is removed the IR levels will be higher, so workers installing a new anode might be exposed to irradiance levels of 150-160 mW/cm^2. The anode is pulled out of a pot, hoisted about 8 feet off the ground, and then moved slowly by the crane to the anode refurbishing area. The IR irradiance levels from the used anode was estimated by placing it on the ground rather than trying to measure a suspended object. With the thermopile on the floor, at a distance of 4 feet from the used anode, measurements were made at various time intervals to determine the IR drop-off rate. Figure 3 clearly shows that these anodes may take as long as 30 minutes to cool off, further amplifying the requirement for workers associated with such tasks to wear protective equipment. Occupational exposure to the IR emitted by the suspended anode is minimal once crane movement begins. It should be noted that since the crane operators are in a protective housing, their exposure to IR is minimal.

D. Static magnetic fields

While there is interest in determining levels of occupational exposure to magnetic fields, very few reported studies have been made on workers actually exposed to such fields. Therefore, the technique and measurement protocols are not well established.

Approximately 200 to 300 measurements of static magnetic fields were made at the facility covering every potroom, areas where the buss bars entered the cell room(s), locations where workers were seen on the days of measurements, offices and rest rooms. Every attempt was made to document the highest reading for every location. This type of measurement requires slowly rotating the probe within a small 10 inch sphere space while noting the position that gave the maximum reading. Rather than report each reading, the data is pooled into a descriptive narrative that should aid the safety office in understanding the general exposure pattern that was observed on the day of the measurements. The facility safety office should perform a more detailed area evaluation in the near future. At this point in time the lack of instrumentation or dosimetry techniques prevents the ability to monitor an individual worker for exposure to magnetic field.

Static magnetic field (SMF) measurements taken less than 6 to 12 inches from the buss bar and at chest height, gave levels ranging from 200 to 300 gauss. SMF measurements taken at 2 to 3 feet from the buss bar, and at chest height, gave levels ranging from 30 to 60 gauss. SMF measurements taken on several catwalks between two adjacent pots gave levels ranging from 70 to 150 gauss depending on where the probe was held. While taking these measurements it was noticed that the higher the probe was held above the ground, the higher the SMF level. The exception to this generalization was that levels recorded for crane operators were almost non-detectable. SMF levels produced in pipes and near circular objects gave levels as high as 700 gauss. Pipes, which jut out from the end of the pots, represent small point sources that can easily be capped or shielded.

The highest fields measured were where the buss bars entered the potrooms. In potrooms #1 through #5, the buss bar entered the room by a overhead route. Static magnetic fields ranging from 1200 to 1500 gauss were measured in the areas near cell line 1 in all potrooms. The SMF levels may be higher behind the locked doors leading to the overhead buss bar area; however, time did not permit evaluation of these secured locked areas. No worker was seen entering or leaving these locked areas on the days of measurements. In potroom #6 SMF levels as high as 1400-1600 gauss were measured over an 8 square foot area at the rear of the room.

Table 2 compares the maximum measured radiation levels at Ormet with the 8-hour time weighted average occupational exposure guidelines from ACGIH.

VII. CONCLUSIONS

This evaluation clearly indicated that high levels of infrared radiation and static magnetic fields exist at the Hannibal facility. While the significance of such exposures have been discussed earlier in this report, there may be other concerns from these exposures, especially infrared radiation.

In a previous NIOSH investigation at Ormet [1] results from a medical questionnaire were presented that dealt with the issues of asthma and shortness of breath. That investigation showed 52% (284/548) of the participants reported some form of shortness of breath, 46% (286/625) reported having wheezing, and 16% (100/625) reported symptoms suggestive of asthma. It should be noted that only 24 actually had asthma cases confirmed by a physician. Nevertheless, these results suggest that some agent at Ormet could be linked to medical symptoms similar to an asthma-like conditions. When the questionnaire data were analyzed the results showed that "Potroom-related, physician-confirmed asthma was not associated with age, smoking status, years at Ormet, or years in the potroom". In addition to this finding, the same evaluation also did not find any environmental contaminants in the facility, on the day of measurements, that would support any type of agent-asthma relationship.

In January 1982 NIOSH published a technical report entitled Biological Effects of Infrared Radiation [5]. On page 58 of this publication several reports are given describing unique biological effects reported from exposure to IR. Two of these effects hold some interest for this evaluation and are cited as follows:

> "A study by Broneff and Blumlein indicated that the upper respiratory passages of iron foundry workers were damaged by many years of exposure to intensive near IR. Chronic rhinitis (in most instances with polyps and hyperphasia of the mucous membranes), chronic laryngitis and sinus trouble were prevalent in almost 50% of the exposed workers. According to this study, these disorders were 5 to 10 times more frequent in the exposed group than in the control group.
>
> Episodes of apnea (a transient suspension of respiration) have been reported in infants exposed to radiant warmers. The relationship between changes in irradiance levels and the incidence of apnea is not known..."

Such reports tend to suggest that workers exposed to high levels of IR might experience drying of the mucous membranes, perhaps shortness of breath, upper respiratory symptoms, and general drying out of moist tissues. These types of effects suggest that perhaps IR alone is a causative agent for producing biological effects in the body that could be interpreted, medically, as asthma-like symptoms. If this is true, as the literature suggests, then protection from excessive IR exposure may eliminate or minimize such effects.

Discussions with several workers regarding exposure to SMFs did not reveal any unusual adverse health effects except for possible hand/arm/wrist deviations. Rational, for this thought comes from examining the OSHA injury/illness log for 1988 where it was shown that a high (>50%) percentage of potroom safety related accidents involved the hand/fingers, the forearms, and the lower back. The NIOSH investigators believe that one possible major contribution to these types of accidents may be associated with the metal rods used in the potroom areas to break up the slag formed in the pots. All of the rods used at the facility are attracted to the metal surrounding the pot due to the presence of strong magnetic fields. To use the rods it is necessary for the workers to exert sufficient force, many times daily, to overcome the force of attraction between the rod and the metal on which it contacts. This attraction may contribute to hand/arm/wrist deviations and stress which could play a role in accidents. Unfortunately, it is difficult to verify this hypothesis since many workers do not report all injuries and safety related incidents involving magnetic fields. Several workers told NIOSH investigators that they became accustomed to "wrestling" with the rods. The NIOSH investigators would like to recommend the use of lighter weight material to break the crust built up inside the pot instead of the present heavy metal pole (see Figure 4)

Workers can reach the elevated pot locations from the various pot room floors by walking up small steps (ladders) that were positioned close to every pot and the buss bar. In general, most of these ladders are rigidly affixed, but during the evaluation of IR and magnetic fields near the pot lines NIOSH investigators observed that several ladders were loose and fell off their mounting when stepped on. The safety personnel were alerted to this finding by the NIOSH investigators during the evaluation. We believe that these ladders represent a trip/fall hazard and require immediate attention.

VIII. RECOMMENDATIONS

The following recommendations are offered to reduce potentially significant occupational exposures and safety risks at Ormet:

1. Ormet Corporation should consider purchasing appropriate static magnetic field monitoring instruments for use at the various areas within the facility, especially during service and maintenance activities.

2. The Health and Safety Group should continue to monitor for levels of static magnetic fields produced at various sites within the plant. It may be important that such measurements be taken to assist in the evaluation of potential adverse health effects for workers exposed on a short-term or chronic basis.

3. It is recommended that workers who are involved with slag breaking and anode extraction procedures shall take precautions such as wearing eye and face protectors, covering unprotected skin areas, closing all pot doors unless working on them, and maintaining as much distance between the open pot and themselves during slag breaking.

4. Where the job task of workers require them to fixate on hot objects emitting high or uncomfortable levels of infrared radiation, it is

appropriate for Ormet employees to consider wearing of tinted eyewear to minimize dry eye conditions. On the day of measurements several workers were wearing tinted eyewear which did not prevent them for performing their duties.

5. Figure 4 shows a conceptual design for a pot slag breaker we believe will aid in minimizing overall hand, arm, and back accidents in addition to providing a suitable tool to perform the same tasks being done with the present design.

6. The safety office should post various areas within the facilities as high magnetic field areas. The ability to post such information will, of course, be dependent on purchasing the appropriate instrumentation. The posting of these areas should indicate levels of fields, the need to remove various metal objects, (including perhaps credit cards), and warnings about the presence of metallic implants.

7. The high levels of IR and magnetic fields require emphasis from the standpoint of both worker awareness and development of managerial and engineering control methods. One of the better control methods that should be employed is shielding. Shielding of IR can be accomplished with opaque or reflective barriers [13-14], tinted eyewear, or insuring that doors are closed as much as possible. Shielding of magnetic fields is accomplished by using a material of high permeability to provide a pathway for the flux away from a given area. All areas where levels above 600 gauss are identified should be examined for possible shielding. Extremely high areas (i.e. above 1000 gauss) should be controlled with automated systems or restriction placed on the workload.

8. The investigators suggest that all the potrooms, as well as the open areas between the pot rooms, be posted and labelled as a magnetic field area. In addition, the doors leading to the overhead buss bar location in potroom #1 - #5 need to be labelled "high magnetic field" areas. Additional control measures will have to be considered by safety personnel for those periods when maintenance/electrical workers are required to enter these areas. It may be prudent to consider reducing or eliminating the level of electrical current passing the buss bar for those time periods. Since the buss bar in potroom #6 goes under the floor, rather than overhead, these magnetic fields are much higher for workers. Again, posting of this area with signs should be performed immediately, with attention given to minimizing worker access to such fields.

9. During the facility tour the NIOSH investigators entered the plant medical section and learned that annual exams are offered by Ormet. However, we were informed that employees are reluctant to

participate in these services. We believe that this service should be advertised and encouragement given to participate. However, during this visit we were informed that annual chest x-ray exams were being performed. Unless these x-ray exams are performed for a specific diagnostic purpose, it may not be necessary to have them performed annually.

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Ormet Corporation, Hannibal, Ohio
2. United Steelworkers of America, Local 5724
3. NIOSH, Cincinnati Region
4. OSHA, Region V

For the purpose of informing affected employes, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE 1

Optical Radiation and Static Magnetic Field
Evaluation Criteria and Health Effects Summary

Ormet Corporation
Hannibal, Ohio
HETA 88-229
January 17-18, 1989

Physical Agent	Evaluation Criteria*	Primary Health Effect
Ultraviolet (200-315 nm)	0.1 eff uW/cm^2	photokeratitis and erythema
(315-400 nm)	1.0 mW/cm^2	
Visible (400-760 nm)	1.0 cd/cm^2	retinal burns
Infrared (760 nm-1 mm)	10 mW/cm^2	dry eye/skin cataracts
Static Magnetic Fields	600 gauss	effect activity of blood and muscles

* Values represent 8-hour exposure, but higher exposures are permitted in certain cases at shorter time periods.

TABLE 2

Comparison of maximum measured radiation field at Ormet with occupational exposure limits.

Ormet Corporation
Hannibal, Ohio
HETA 88-229
January 17-18, 1989

Radiation Field	Maximum measured value	Occupational exposure limit
Actinic UVR (200-315 nm)	ND	0.1 eff uW/cm^2 in 8-hour day.
Near UVR (315-400 nm)	120 uW/cm^2	1.0 mW/cm^2 for time periods >16 minutes.
Luminance	0.3 cd/cm^2	1.0 cd/cm^2 in 8-hour day.
Infrared	190 mW/cm^2	10 mW/cm^2 in 8-hour day.
Static Magnetic	1600 gauss	600 gauss in 8-hour day.

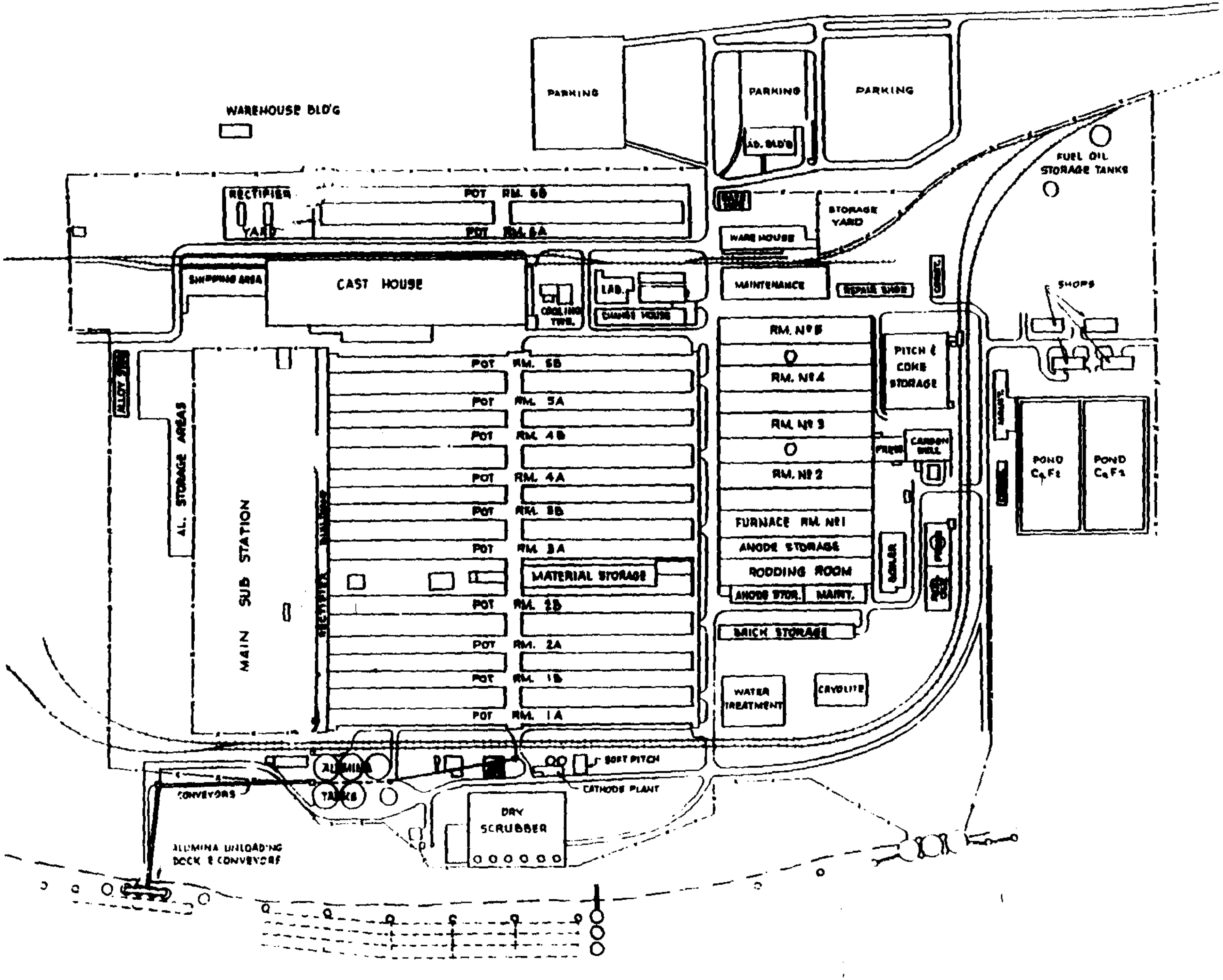


Figure 1. Floor plot plan of the Hannibal Facility

Figure 2. IR irradiance as a function of distance from open door of pot.

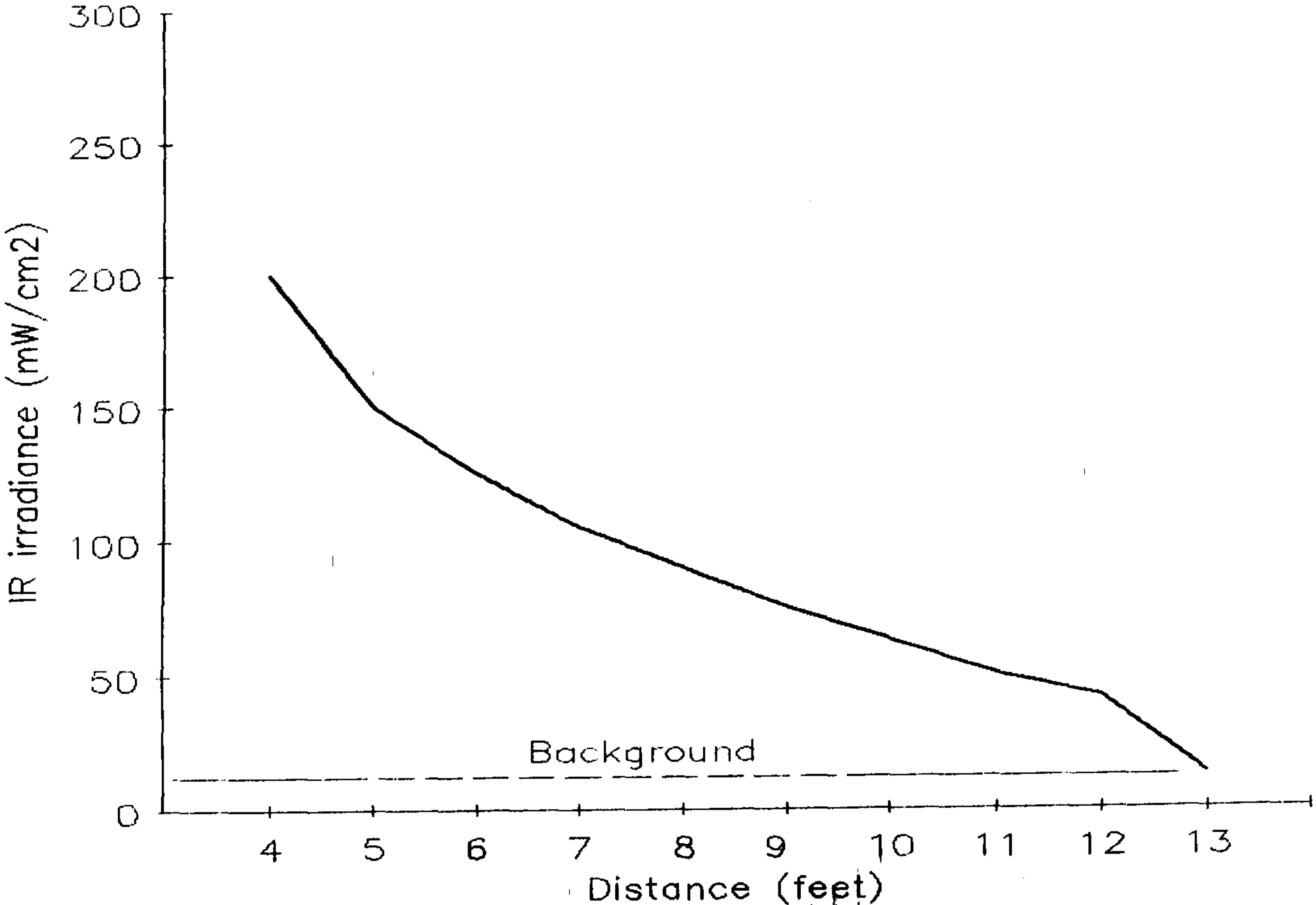


Figure 3. IR irradiance of anode as a function of time after removal from pot.

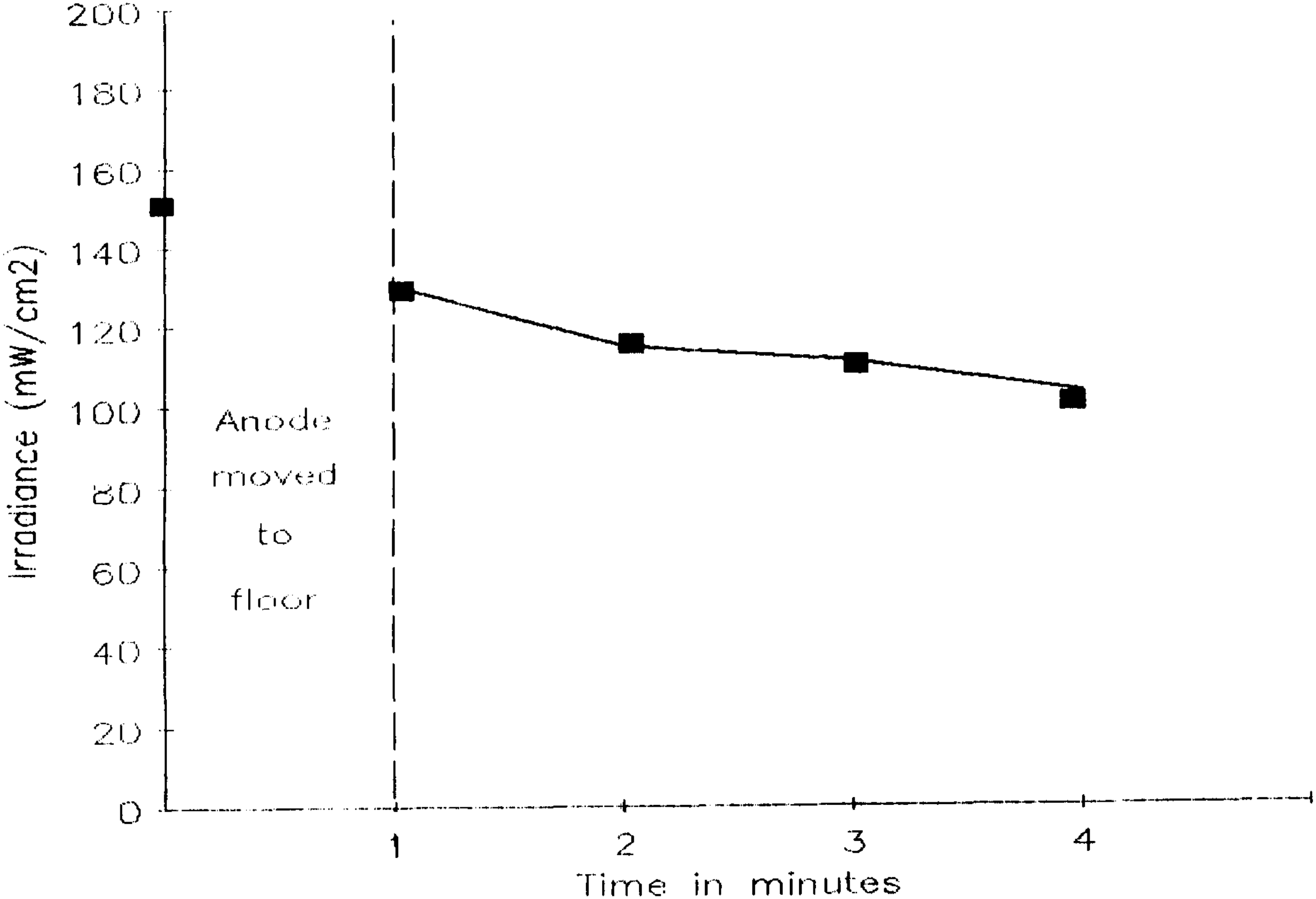
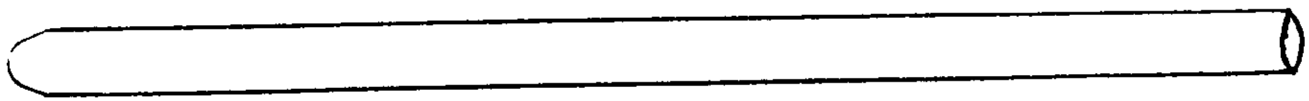
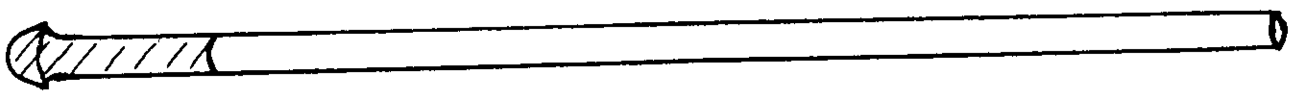


Figure 4. Contrast between old and prototype new design for metal bar used to break pot slag.



Present design. Entire bar is metal, weighting about 30 pounds and can be easily attracted by magnetic field.



Prototype new design. Only the front section made of metal, the remaining portion made of aluminum or other lightweight metal. Weight might be 5 to 10 pounds and not easily attracted by magnetic fields.